

Experimental Evaluation of the Seismic Performance of Hospital Piping Subassemblies

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ABSTRACT

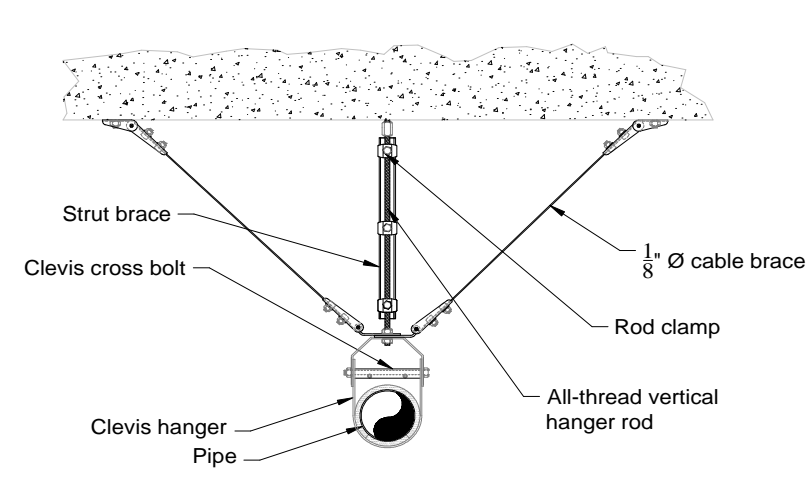
The operation of a hospital after an earthquake relies heavily on its nonstructural components. The nonstructural components of a building are those systems, parts, or elements that are not part of the structural load-bearing system. These systems are susceptible to damage during earthquakes. Any damage to these systems can cause substantial economic loss as well as functional loss of the building's systems. Piping subassemblies are critical parts of a nonstructural building system and understanding their seismic response is very important.

BACKGROUND

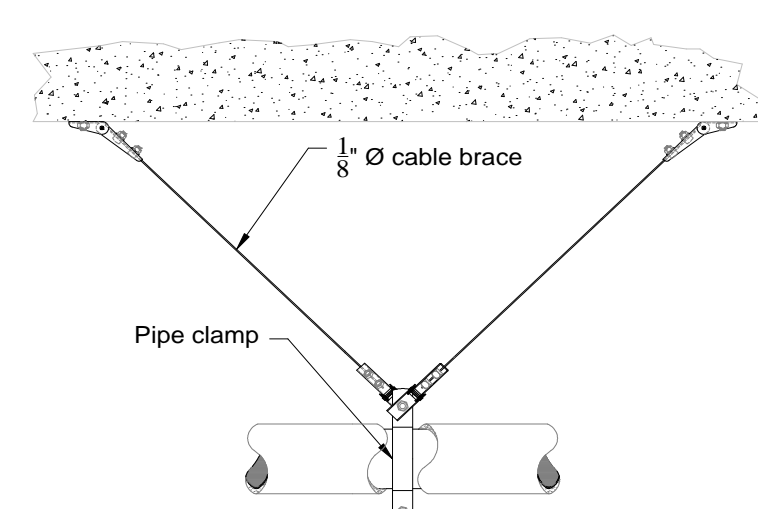
The basis for this research and analysis is to investigate the seismic performance of hospital piping subsystems. Two steel piping subassemblies with identical geometries were tested in the Rogers Wiener Large Scale Structures Laboratory at the University of Nevada, Reno. The experimental piping subassembly was modeled after a typical subassembly in a California hospital. The two subassemblies differed only by their connection details. One subassembly had welded connections while the other had threaded connections. The welded and threaded subassemblies were then tested with and without seismic bracing. Future testing consists of establishing two copper piping subassemblies with identical geometries but like the steel differ only by their connection detail. From this we will be able to determine what material and connections will minimize nonstructural damage.

OBJECTIVES

- Select a typical hospital piping system and subject it to intense input motions
- Observe and compare the response of welded and threaded systems
- Identify the weak points of each system with and without braces



Transverse Brace



Longitudinal Brace

METHODS

Overview of previous Experimental Results:

- System modeled after University of California, Davis Medical Center piping system
 - Modified to accommodate dimensions and geometry restrictions of testing facility
- 100 feet of 3 inch and 4 inch diameter schedule 40 ASTM A-53 grade A black steel pipe
- Four typical valves
- Two water heaters and a single heat exchanger which were all anchored to the shake table
- 4 systems tested
 - Welded braced
 - Welded unbraced
 - Threaded braced
 - Threaded unbraced
- Each system subjected to increasing intensities of SIMQKE and RSCTH motions

Status of Current Work:

- Piping system geometry will still be modeled after U.C. Davis Medical Center
- Copper piping system consisting of typical components (valves, water heater, heat exchanger, pipe hangers, bracing)
- The soldered copper piping will be braced and hung from the stationary steel structure used in the previous experiment.
- Relative acceleration time-histories obtained from the dynamic analysis of Northridge Near Fault Ground Motions will be utilized as input motions in the laboratory.

RESULTS

The following results refer to the steel piping subassemblies obtained from the previous experiment. The braced welded subassembly was subjected to story drifts up to 4.34% with no damage. The braced threaded subassembly began to leak at 2.17% and failed at 4.34%. The unbraced welded subassembly was subjected to story drifts up to 4.34% with no damage. The unbraced threaded subassembly began to leak at 1.08% story drift. The welded piping subassemblies exceed the 1997 UBC requirements on drift without damage. The threaded piping systems did not meet the 1997 UBC requirement on drift.

CONCLUSIONS

In conclusion the seismic performance of the steel piping subassembly experienced specific dynamic characteristics. No spectral response above 0.5 second input was used for either braced subassembly. The unbraced threaded subassembly had the longest periods meaning it exhibited more flexibility. The braces significantly reduced the system displacement response but did not reduce the system acceleration response. Overall, the welded systems performed very well while the threaded systems had weak points near the fittings.

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